

Detection of Pulmonary Tuberculosis

Comparative Value of Routine Radiologic Examinations and Routine Laboratory Procedures

HOMER D. PEABODY, JR., M.D., and R. H. SUNDBERG, M.D., *San Diego*

SUMMARY

The abnormalities disclosed by the usual laboratory diagnostic procedures (blood cell count and hemoglobin determination, sedimentation rate determination, urinalysis, and serologic test for syphilis) are compared with the number revealed by stereophotoroentgen chest examination in a series of 951 patients.

The number of significant abnormalities uncovered by the routine stereophotoroentgen examination of the chest was comparable to the number disclosed by the usual laboratory procedures used in patient evaluation.

Some form of radiologic examination of the chest should be included in the routine laboratory procedures required for patient evaluation.

THE value of some form of radiologic chest examination in the detection of unsuspected pulmonary tuberculosis has been proved by numerous surveys. The value of such a procedure as a routine part of the complete patient evaluation, however, has not been generally recognized or admitted. Certain laboratory studies, namely, urinalysis, blood cell count, sedimentation rate determination, and serologic examination for syphilis, are considered essential parts of such a case study, and omission of them would be cause for criticism in most clinics and hospitals. Unless there are specific complaints referable to the respiratory system, however, radiologic chest examination may not be made. The study to be reported here was undertaken for two reasons: (1) to compare the number of significant abnormal findings disclosed by the usual laboratory procedures and by roentgen examination of the chest, in the same series of patients, and (2) to demonstrate, on the basis of the comparative amount of pulmonary disease thus uncovered, the value of including some form of radiologic examination of the chest among the routinely required laboratory procedures for patient evaluation.

It has been reported that routine blood cell counts reveal blood dyscrasias in a small fraction of one per cent of patients.¹⁰

Joslin⁶ estimated that routine analysis of urine uncovered diabetes in 0.4 per cent of patients examined. Wilkerson and Krall¹¹ reported a survey of 3,500 citizens of Oxford, Massachusetts, in which 40 cases of diabetes known to physicians, and 30 additional unknown cases, were found. It is estimated that there are at least 1,000,000 undiagnosed cases of diabetes in this country.

Routine serologic tests for syphilis were positive in 2.4 per cent of white males examined for Selective Service.⁹

Tuberculosis revealed by mass chest radiography in United States Selective Service examinations was the cause of rejection in 1.4 per cent of examinees.³ Graham² reported that in a series of 2,067 obstetrical patients observed in private practice, routine roentgenologic chest examinations revealed active tuberculosis in 0.77 per cent and significant parenchymal disease in 3.44 per cent. Block and his associates¹ found significant abnormalities by fluoroscopic examination in 21.3 per cent of 15,000 University of Chicago students. They concluded that in the 15 years prior to the introduction of routine x-ray examination, 3,000 patients with clinically important pulmonary tuberculosis passed through the outpatient department without detection of the disease. They estimated that throughout the country 600,000 tuberculous persons undergo medical examinations each year without detection of this condition. Hodges⁵ at the University of Michigan Hospital found, by photofluorographic chest examination of 7,841 patients, deviations from normal in 14.1 per cent and abnormalities demanding more extensive x-ray examination in 9.3 per cent.

In a study of 153 patients with carcinoma of the lung Overholt⁷ discovered that in 60 per cent not only had an incorrect diagnosis been made, but treatment based on that diagnosis had been maintained for long periods of time. In the series he reported, the length of time elapsing between the onset of symptoms and consultation with a physician averaged three months. Three months more elapsed before the physician requested chest x-ray studies, and the correct diagnosis was not made until another six months had passed. Thus definitive treatment was delayed for an average of nine months from the time of the first consultation. Early chest roentgenograms with necessary additional study would have obviated many months of delay.

From the Department of Diseases of the Chest, Rees-Stealy Clinic, San Diego.

The figures cited are the results of independent surveys in different groups of individuals. In the study here reported the results of five laboratory procedures, all applied to each patient, are compared.

For this purpose, the records of 951 patients, treated on a private practice basis, who consulted the diagnostic section of this Clinic from August through December, 1947, were taken at random. No records of hospitalized patients were included. There were 336 males and 615 females in the series. The ages ranged from 12 to 82 years with an average of 42.9 years for males and 40.5 years for females. In all of these cases, a full history was taken, a complete physical examination made, and laboratory procedures consisting of a complete blood cell count, hemoglobin and sedimentation rate determinations, urinalysis, serologic examination for syphilis, and stereophoto roentgen examination of the chest were carried out. Other investigative procedures depended upon indications in the individual case. It should be emphasized that many patients with specific chest complaints were not included in the group, since such patients were sent directly to the department of diseases of the chest for study. Neither were any obstetric patients included. With these two exceptions, the series represents a cross-section of adult patients observed in private practice.

PHOTOROENTGEN CHEST STUDIES

The merits of various screening methods for chest disease will not be discussed here. Hilleboe and Morgan⁴ have covered this subject well. This clinic uses the photoroentgen method which utilizes the 4x5 inch stereo film, the advantages of which have been summarized by Potter, Douglas, and Birkelo.⁸ It is the opinion at this clinic that photoroentgenograms made by this method, when interpreted by a competent roentgenologist, constitute a dependable screening method for existing chest disease. The inconvenience to the patient is slight and no more time-consuming than the drawing of a blood sample.

Analysis is based on results of chest photoroentgenograms in 951 cases. Normal findings were reported in 758 cases (79.7); some form of definite abnormality was found in 148 cases (15.6 per cent); and equivocal or indefinite findings in 45 cases (4.7 per cent). (See Table 1.) The percentage of cases in which definite abnormalities were found is slightly lower than that reported for screening methods by other observers. There are three possible explanations for this difference: (1) although further roentgenographic investigation in the 45 cases in which indefinite or equivocal findings were

TABLE 2.—*Abnormalities Revealed by Stereophotoroentgen Examination in 951 Cases*

	No.	Per Cent
<i>Lung lesions</i>	77	8.1
Minimal tuberculous lesions.....	7	
Hilar and parenchymal calcification and/or scarring	55	
Pulmonary fibrosis	6	
Increased markings	4	
Emphysema	4	
Thoracoplasty for tuberculosis.....	1	
<i>Pleural lesions</i>	10	1.1
Calcified pleura and/or old scarring..	7	
Pleural effusion	3	
<i>Cardiovascular lesions</i>	44	4.7
Enlarged heart	34	
Enlarged aorta	9	
Aortic aneurysm	1	
<i>Skeletal lesions</i>	7	0.7
Scoliosis	3	
Fractured ribs	2	
Tuberculosis of spine.....	1	
Osteomyelitis of rib.....	1	
<i>Tumors</i>	2	0.2
Dermoid cyst	1	
Enlarged nodes	1	
<i>Miscellaneous</i>	8	0.8
Cervical rib	2	
Thyroid enlargement	4	
Substernal thyroid	1	
Calcified cervical nodes	1	
<i>Abnormal photoroentgenograms</i>	148	15.6
<i>Additional roentgenography requested..</i>	45	4.7
<i>Negative photoroentgenograms</i>	758	79.7

reported revealed significant abnormalities in a high percentage of them, these were not included in the total figure; (2) few patients with specific chest complaints were included in the study; and (3) minor deviations from normal (minute calcifications) were considered insufficient to warrant a report of abnormality.

A summary of abnormalities found is given in Table 2. Significant pulmonary disease was found in 21 cases (minimal active tuberculosis in seven, pulmonary fibrosis in six, emphysema in four and abnormally increased markings in four). Definite evidence of parenchymal disease characterized by hilar or massive calcifications throughout both lung fields was noted in 55 cases. The incidence of minimal tuberculosis (seven cases) is significant and should be emphasized.

SEROLOGIC EXAMINATIONS FOR SYPHILIS

The reaction to the standard Kahn test for syphilis was positive in eight (0.84 per cent) of the 951 patients examined and results of Kolmer-Wassermann tests were positive in six cases (Table 3). In these eight cases, a diagnosis of syphilis was made and treatment instituted.

SEDIMENTATION RATE DETERMINATIONS

The Westergren method of determining the sedimentation rate was used in this study. The normal value for males is usually considered to be from 0 to 15 mm. and for females from 1 to 20 mm. in one hour. Many of the workers at this clinic feel that these accepted normal values are too low; they consider a significant rate to be over 20 mm. in one

TABLE 1.—*Results of Stereophotoroentgen Chest Examinations*

	No.	Per Cent
Patients examined	951	
Patients with abnormalities.....	148	15.6
Patients requiring additional roentgenographic study	45	4.7
Patients with negative findings.....	758	79.7

TABLE 3.—Results of Serologic Tests for Syphilis

	No.	Per Cent
Total number of cases.....	951	
Positive reactions	8	0.8
Negative reactions	943	99.2

hour for males and over 30 mm. for females. On the basis of the latter values, there were 159 patients (16.8 per cent) with higher than normal rates (Table 4). Of these, 58 were males and 101 females. It should be pointed out that these reported levels of sedimentation activity were not corrected for anemia and that slight anemia was frequently present.

TABLE 4.—Results of Sedimentation Rate (Westergren) Determinations*

	Male	Female	Total	Per Cent
Total number of cases.....	336	615	951	
Abnormal rates	58	101	159	16.8
Normal rates	278	514	792	83.2

*Normal range: Males 0-20 mm., females 0-30 mm. in one hour.

HEMOGLOBIN DETERMINATIONS

Blood-analysis in all cases in this series included determination of hemoglobin concentration, and counts of erythrocytes, leukocytes and differential leukocytes, but only the hemoglobin concentration values have been tabulated. Inasmuch as most deviations from normal in the blood analysis occurred in the hemoglobin value, it is considered satisfactory for this comparative study. On the basis that 15 gm. of hemoglobin per 100 cc. of blood equals 100 per cent, the hemoglobin concentration values were below 75 per cent (11.5 gm. per 100 cc.) in 70 cases (7.4 per cent) (see Table 5). In four cases the patients were males; in 66, females. No cases of leukemia or other blood dyscrasias were observed in this series.

TABLE 5.—Results of Hemoglobin Determinations*

	Male	Female	Total	Per Cent
Total number of cases.....	336	615	951	
Abnormal results	4	66	70	7.4
Normal results	332	549	881	92.6

*Normal: 11.5 gm. per 100 cc. (75%) to 15 gm. per 100 cc. (100%).

URINALYSES

There were significant deviations from normal in the urine of 124 patients (13.1 per cent) (Table 6). Sugar appeared by the Benedict's reducing test in five cases, and in all of these cases further studies revealed the presence of diabetes mellitus.

DISCUSSION

A numerical summary of the abnormalities disclosed by the usual laboratory procedures and by the routine stereophotoröntgen chest examination in the series of 951 patients is given in Table 7. These findings are evidence of the importance of

TABLE 6.—Results of Urinalyses

	No.	Per Cent	No.	Per Cent
Total number of cases.....			951	
Abnormal results			124	13.1
Leukocytes	54	5.7		
Erythrocytes	8	0.9		
Albumin	57	6.0		
Sugar	5	0.5		
Normal results			827	

these laboratory procedures in the evaluation of the patient's condition either as screening procedures or as specific tests. The fact that most patients referred directly to the department of diseases of the chest were excluded from this study gives added significance to the results of stereophotoröntgen examination of the chest in routine practice.

TABLE 7.—Summary of Results of Routine Laboratory Procedures in 951 Cases

Procedures	Number of Cases in Which Abnormalities Were Present			
	No.	Per Cent	No.	Per Cent
Photoroöntgen chest examinations....			148	15.6
Significant pulmonary disease.....	21	2.2		
Minimal active tuberculosis.....	7	0.7		
Cases in which additional roentgenographic chest study was required	45	4.7		
Serologic test for syphilis.....			8	0.8
Sedimentation rate (Westergren) determination			159	16.8
Hemoglobin determination			70	7.4
Urinalysis			124	13.1
Sugar reduction for diabetes.....	5	0.5		

The number of patients in whom clinically significant abnormalities were demonstrated as a result of the photoroöntgen chest examination, was comparable to or greater than the number of patients in whom significant abnormalities were demonstrated by laboratory screening procedures usually considered essential—hemoglobin and blood sedimentation rate determinations, and urinalysis. The number of cases of clinically important pulmonary tuberculosis uncovered as a result of further study of chest abnormalities was comparable to the number in which disease was revealed by the more specific serologic examination of the blood for syphilis and to the number in which diabetes mellitus was disclosed by further studies in cases in which sugar was found in the urine.

It is the authors' opinion, as a result of this survey, that some form of radiologic examination of the chest is as important in the evaluation of a patient as are the laboratory procedures which are usually considered essential in such an evaluation.

REFERENCES

1. Block, R. G., and Tucker, W. B.: Indispensability of routine x-ray examinations of chest in general clinic, *Am. Rev. Tuberc.*, 50:405-417, Nov. 1944.
2. Graham, H. K.: Routine chest roentgenograms in pregnancy; a supplementary study, *West. J. Surg.*, 55:438-441, Aug. 1947.

3. Greve, C. H., Clark, M. L., McGill, K. H.: Physical examinations of Selective Service registrants, January 1944-August 1945, Medical Statistics Bulletin No. 4, National Headquarters, Selective Service System, Washington, D. C., June 1, 1946, p. 12.
4. Hilleboe, H. S., and Morgan, R. H.: Mass Radiography of the Chest, Year Book, Chicago, 1945, pp. 22-42; 98-125.
5. Hodges, F. J.: Fluoroscopic examination of the chest, Radiology, 38:453-461, April 1942.
6. Joslin, E. P., Root, H. F., White, P., and Marble, A.: The Treatment of Diabetes Mellitus, Lea & Febiger, New York, 7th ed., 1940, p. 38.

7. Overholt, R. H.: A common masquerading lung disease, New York State J. Med., 42:1657-1662, Sept. 1, 1942.
8. Potter, H. E., Douglas, B. H., Birkelo, C. C.: The miniature x-ray chest film, Radiology, 34:283-291, March 1940.
9. Results of serological blood tests for syphilis on Selective Service registrants, U. S. Public Health Service, Federal Security Agency, Oct. 1942.
10. Wilson, N. J.: Early diagnosis of disease of the chest, New England J. Med., 232:301-309, March 15, 1945.
11. Wilkerson, H. L. C., and Krall, L. P.: Diabetes in a New England town, J.A.M.A., 135:209-216, Sept. 27, 1947.



A Simple Infant Transfusion Kit for Occasional Use

W. R. MACLAREN, M.D., *Pasadena*

MANY occasions on which a small transfusion would benefit a sick or convalescent infant are passed up because of the technical difficulties involved. Usually the major stumbling block is lack of equipment, particularly sterile tubing. Few physicians care to assemble, autoclave and put aside equipment that is used so seldom.

However, a satisfactory infant transfusion set can be assembled on short notice from materials already available in most offices. Required are:

- One 50 cc. syringe with adapter.
- One 10 cc. Luer-Lok® syringe.
- One three-way stopcock (from lumbar puncture set).
- One set disposable plastic intravenous tubing (Baxter or Abbott).

The plastic tubing is packed in sterile condition, has a needle adapter on one end, and costs little. After the syringe and three-way stopcock are boiled, a length of the plastic tubing (15 to 20 inches) is cut with sterile scissors and attached to the small arm of the three-way stopcock where it is firmly tied with heavy thread. The needle adapter and any other slip joints in the tubing are also tied. The assembly is completed by attaching the two syringes to the proper arms of the three-way stopcock. The plastic tubing is discarded after it has been used.

A suggested routine for using the kit in the office follows:

The blood of the infant and of the donor is cross-matched. An 18-gauge needle is attached to the 50 cc. syringe and 8 cc. of sterile 2.5 per cent sodium

citrate solution placed in the syringe. Forty-five cc. of blood is drawn rapidly from the donor so that the turbulence in the syringe produces adequate mixing of the blood and citrate without shaking.

The 10 cc. syringe, which is in place on the three-way stopcock, is used to fill the stopcock, the tubing and the needle with sterile saline solution (from a rubber capped vial) and a few cubic centimeters of the solution is left in the syringe. After the needle is inserted under the skin, gentle traction on the syringe will bring blood into view in the adapter as soon as the vein is entered. This is very helpful in dealing with small veins.

The large syringe is then attached to the three-way stopcock and blood introduced either directly or by repeatedly filling the 10 cc. syringe. The smaller syringe is the more easily controlled.

Many variations suggest themselves. If only slight pressure is needed, the large syringe can be suspended as a gravity reservoir. After the blood has been given, a saline drip can be connected to the three-way stopcock if desired.

The advantages of this arrangement are: (a) the parts are standard items of office equipment; (b) the parts can be assembled in a few minutes, and returned to their ordinary function after use; (c) the use of disposable plastic intravenous tubing is inexpensive and makes autoclaving and storage of rubber tubing unnecessary.

127 North Madison Avenue.